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The Role of Learning Styles in Student Evaluations of a Problem-based Learning Course

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1. Abstract:

I investigated the relationship between student learning styles and student evaluations of problem-based learning in a wildlife ecology and management course. I used two surveys for my inquiry: an on-line survey to determine student learning preferences, and an end-of-course survey of student reactions to problem-based learning (PBL). Forty-one students completed both surveys, and students' learning preferences varied. I found significant relationships between learning preferences and student evaluation of PBL. Students with more active learning preferences found more value in the group learning experiences in my course. Group learning is often a critical component in problem-based learning courses, and my inquiry provides direction to solve problems with group dynamics. Problem-based learning may provide critical skills for professional development, but active learning may not be well-matched for all students.

Key Words:

Group dynamics, group learning, learning styles, problem-based learning, professional development.

2. Introduction

Students differ in their preferences for gathering and processing information—the 'style' of their learning. Students may see or hear, reflect or act, reason intuitively or logically, memorize or visualize. Students may learn steadily or in bursts (Felder, 1988). Instructors must consider their students' learning styles as they plan learning experiences. Lectures, demonstrations, applied case problems, discussions, or laboratory identification invoke different styles of learning. As Felder and Spurlin (2005) note, when the learning styles of the majority of the students and the instruction style of the professor are poorly aligned, students will be bored in class, uncomfortable, disengaged, and discouraged. In addition, students may do poorly on assessments.

I am a wildlife ecologist; the field of wildlife ecology, as with most academic fields, has arisen from a history of lecture-based education. However, because of the applied nature of wildlife ecology programs, I hypothesized that wildlife ecology instruction may not be as mismatched with student learning styles as engineering (Felder, 1988). Wildlife teaching faculty have used active learning methods such as problem-based learning and experiential learning (Ryan & Campa, 2000; Millenbah & Millspaugh, 2003). The move to active learning methods is, in part, a response to improve the professional development of students through real-world experiences (Moen et al., 2000); active learning also improves critical thinking and problem-solving skills (Ryan & Campa, 2000). Although problem-based learning may provide critical skills for professional development, it is possible that active learning may not be well-matched to every wildlife student.

Felder (1988) suggested that traditional engineering education was mismatched with common learning styles of students. Engineering faculty often became frustrated with student results, becoming overly critical of students; this phenomenon, of course, was counterproductive. Typically, engineering faculty lectured and students attempted to reproduce the lecture information in exams (Felder & Brent, 2005). But, the learning styles of engineering students surveyed in many universities showed an overwhelming majority (usually around 80%) were visual learners and approximately 60% were active learners who usually enjoy working in groups (Felder & Spurlin, 2005); lectures are more suited for verbal and reflective learners. Felder (1988) feared that the engineering profession was losing potentially excellent engineers because of learning style mismatch in college courses.

There are many ways of assessing learning style preferences. Classic examples are the Myers-Briggs Type Indicator (Lawrence, 1994) and Kolb's learning style model (Kolb, 1984). For my investigation, I chose the Soloman and Felder model (Felder & Silverman, 1988), which is a broad assessment of student learning and is validated as being analogous to portions of the Myers-Briggs and Kolb models (Felder & Spurlin, 2005). The Soloman and Felder model ranks students along a continuum between two poles of the following four dimensions (Felder & Spurlin, 2005):

- **Sensing or Intuitive.** Sensing: concrete thinker, practical, oriented toward facts and procedures; Intuitive: abstract thinker, innovative, oriented towards theories and underlying meanings.
- **Visual or Verbal.** Visual: prefer visual representations of presented material, such as pictures, diagrams, and flow charts; Verbal: prefer written and spoken explanations.
- **Active or Reflective.** Active: learn by trying things through, enjoy working in groups; Reflective: learn by thinking things through; prefer working alone or with a single familiar partner.
- **Sequential or Global.** Sequential: linear thinking process, learn in small incremental steps; Global: holistic thinking process, learn in large leaps.

My interest in learning styles was not to create the 'perfect learning experience,' which would reach all students equally well. In fact, Felder and Brent (2005) suggest that such a method does not exist. Because of diversity in student learning styles, it would be impossible to educate optimally even a small class of students. Instead, my goal was to assess problem-based learning as a learning experience. Although I have used problem-based learning in all of my courses for many years, I lacked knowledge of how individual students reacted to the approach.

3. About the course

Wildlife Ecology and Management (Table 1) is a course taken during the sophomore or junior year. It is designed to apply basic ecological principles to problems in fisheries and wildlife management. My course is a required course for Fisheries and Wildlife students, and precedes an upper-level techniques course in either fisheries or wildlife management in our major's curriculum. I have used problem-based learning methods to teach the course since 2002. I have designed 4 PBL units for the course (Powell, 2008):

- Nebraska's Ornate Box Turtle trade (*wildlife law, history of management)*
- Puerto Rico iguana ecology (*wildlife ecology, damage management, conservation biology)*
- Sandhill Crane management and harvest (*managing migratory species, harvest management)*
- Pheasant management/Farm Bill (*habitat management, public policy and management)*

Each unit begins with an in-class reading of a fact-based, ill-structured, fictitious case problem. The students read the problem and work in groups to determine what they would need to do/know to solve the problem. Then, as a class, we list the most important learning issues that need to be dealt with as we proceed through the unit. These learning issues become the focus of the subsequent learning experiences.

4. Development of the inquiry and hypotheses

My student evaluations have generally reinforced my decision to select problem-based learning as a teaching method. However, feedback from students also suggested that there are a few students who do not enjoy the problem cases and group work associated with the final two problem cases in my course. My investigation focuses on exploring how learning styles impact students' evaluations of problem-based learning.

I developed two hypotheses for my inquiry. The first hypothesis was that students in my course will tend to have active learning styles. I believed that most students in my course had selected a major that was very hands-on and active. Fisheries and Wildlife students tend to work outdoors with their hands, physically engaged in their work. Students have opted not to major in fields such as English or Math, which are perhaps more visual or reflective fields. Part of my justification for teaching with problem-based learning has been that it matches the type of day-to-day work that our students will do in their careers (working with diverse groups to solve problems). My second hypothesis was that students that tend to have more active learning styles will place a greater value on group learning opportunities involved with problem-based learning. I based my hypothesis on my anecdotal observations of the students in the past who have not enjoyed the group work or more active learning in my course.

Objectives

1. Determine range of learning styles for students in my course.
2. Use an end-of-course survey to determine student satisfaction of learning experiences during my course's problem cases.
3. Relate learning style information to evaluations of problem-based learning.

5. Investigative plan

The data for my classroom inquiry were derived from two sources. During the first week of class, I assigned students to take the Soloman and Felder (n.d.) learning styles assessment survey. I will refer to this as the "Learning Style Survey." Students reported their scores to me, and I summarized the Learning Style Survey by calculating the mean

student score for each of the 4 learning dimensions (Felder & Spurlin, 2005). I calculated SD's and quartiles to detect if my students, as a group, tended to have a preference for one pole in each dimension.

The second source of data for my inquiry came from a survey that I conducted during the last two weeks of class. I will refer to this as the "Problem Case Survey." I asked students to rank their response to 9 questions (Table 2). I summarized the Problem Case Survey using frequency tables of responses, because of the categorical nature of the responses.

I then eliminated responses from students who did not complete both surveys. For each of the 9 Problem Case Survey questions, I used an ANOVA-type analysis (PROC GLM; SAS, 2000) to determine if the mean Learning Style rating differed among categories of response. I did this for all 4 dimensions of learning styles, and I calculated least-squared means. I used P-values and confidence intervals around the least-squared means as indicators of significance.

6. Interpreting and evaluating findings

Learning Styles

Contrary to my first hypothesis, the students in my class reported a wide range of learning styles (Table 3). For example, in the Active/Reflective learning dimension, scores ranged from -11 (active) to 11 (reflective), with a mean of -1.2 (mixture of active and reflective). The Sensing/Intuitive dimension also had scores ranging from -11 to 11; the Sequential/Global dimension had scores ranging from -9 to 11.

The only dimension that showed any general direction for the entire class was the Visual/Verbal component, which tended to show a visual preference over verbal. Students reported results from -11 (visual) to 3; thus, no student in my class was high on the verbal end of the gradient. In fact, more than 75% of my class was located in the visual end of the gradient. The standard deviations of the mean values for each component were high again demonstrating a wide range of learning styles among my students.

Problem case survey

Overwhelmingly, students felt that the problem case format of my course provided applied learning experiences and gave them experience dealing with real-world problems (Table 4). However, there was much more variety to the answers about the value of discussion and teamwork to learning, as well as the functional nature of their groups.

Problem case and learning style comparison

My survey provided evidence that learning styles do affect a student's evaluation of problem based learning (Table 2). Forty-one students completed both surveys. Here, I provide an overview of trends in the data that I considered relevant to course decisions. Questions or learning style dimensions not discussed exhibited no trends.

Question 3 (*I thought the 'problem case' format used in this course caused this course to be harder than if another format*): Students who agreed with this statement tended to be more sensing learners (negative values on the scale for sensing/intuitive dimension; P = 0.14), who generally are more practical thinkers who like facts (Felder & Spurlin, 2005). If one interprets 'harder' as "I had to put in more work to get the same grade", then perhaps sensing students thought it would be easier to memorize facts for an exam, rather than working through a problem case in a group.

Question 4 (*I believe I will get a higher grade in this course, because it used the 'problem case' format. My grade would have been lower if another format would have been used to teach the course.*): Students who disagreed with this statement tended to be more active learners (negative scores on the scale for active/reflective dimension). Students who agreed with this statement tended to be reflective learners (positive values; P = 0.23), who generally do not like learning in groups (Felder & Spurlin, 2005). I had predicted that active learners, who enjoy trying things out and working in groups, would be engaged in problem cases. And they were (see below), but they evidently did not agree that the teaching method improved their grade. However, reflective learners, who do not like learning in groups, tended to see a value of problem cases from a grade standpoint. I had anticipated that reflective students would be concerned about their grade in a problem-based learning course. The statistical significance of this result is marginal, but the pattern suggests that students may be more concerned about the activities involved in learning experiences than their eventual grade.

Question 5 (*I believe I have a better understanding of how to approach real-world problems after taking this course.*): Students who agree with this statement were more sequential in their learning styles (negative values on the scale for sequential/global dimension). And, the level of their preference for sequential learning increased with the magnitude of their agreement (P = 0.06, Fig. 1A). The student who disagreed (n = 1) with this statement was a more global thinker, and the student responses did not match my prediction. Students who agreed that they had a better understanding of real-world problems tended to be the most sequential students in my course. Thus, the students who valued the problem-solving experiences they received from problem cases tended to be more linear, sequential thinkers. Perhaps the most sequential learners may have been more satisfied with being done with the assigned problems, while the less sequential learners may still be processing the problem from different angles (Felder & Spurlin, 2005)—not satisfied that they have actually solved the problem.

Question 7 (*The group assignments were valuable experiences, because we had to work as a team to solve a problem.*): Students who disagreed with this statement tended to be reflective learners, who generally do not like to work in groups (Felder & Spurlin, 2005). Students who agreed with the statement tended to be active learners (negative scores on the scale for active/reflective dimension; P = 0.25, Fig. 1B). As I predicted, students who preferred active learning enjoyed learning in groups and valued the time in the group. Students who generally did not enjoy working in groups did not value the learning experiences that were present during the group work.

Question 8 (*I would say that my group had good discussions as we worked on assignments, and those discussions were valuable to my learning experience in this course.*): Students who disagreed with this question tended to be reflective learners,

who generally do not like learning in groups (Felder & Spurlin, 2005). Students who agreed with this question tended to be active learners (more negative scores on the scale for active/reflective dimension; P = 0.28, Fig. 2A), who generally enjoy working in groups. As I predicted, active learners enjoyed working in groups and enjoyed the learning experiences, specifically from discussions, that existed in groups. In contrast, reflective learners did not see the value in those learning experiences, which mirrored the results for Question 7 regarding teamwork (Fig. 1B).

Question 9 (*My group did not function well, and I ended up doing more than my share of the work.*): Students who agreed with this statement tended to be reflective learners, who do not like learning in groups (Felder & Spurlin, 2005). Students who disagreed with this statement tended to be active learners (negative values on the scale for the active/reflective dimension; P = 0.08, Fig. 2B). As predicted, reflective learners were frustrated with group work, because they generally do not like learning in groups (Felder & Spurlin, 2005). I often heard from these students via email or in class, and they could get very discouraged or irritated about their group's interactions or progress. I had previously noted that group members did not agree on the status of their group during a mid-case individual assessment of the group's progress on their project. It was not uncommon to observe 1-2 group members who were disappointed and 2-3 other members who were satisfied with progress.

7. Final reflection

I demonstrated that my students have a variety of learning styles, which is useful information for instructors. It may be useful information for wildlife ecology instructors to know that we have students who learn reflectively and actively—similar to other fields of study. Instructors are often encouraged to provide active learning experiences to our students (Chickering & Gamson, 1987; Millenbah & Millspaugh, 2003), but my survey suggests some students prefer less active experiences. A mixed approach may be the most optimal; student responses to my learning style survey provided evidence that lectures should not be exclusively used throughout a wildlife ecology course. My survey provided evidence that problem-based learning pedagogy can support valuable learning experiences. Students responded positively to the problem case format of my course.

The learning style survey explained much of the variation in responses to six of nine questions on the problem case survey. Although previous research has evaluated the effect of problem-based learning on learning styles of students (Baker et al., 2007), I am not aware of another study that demonstrates a connection between learning styles and student evaluations of a problem-based learning course. I encourage other instructors to consider similar research; faculty can gain valuable information when students are allowed to reflect on their learning experience.

Group dynamics are difficult to manage (Blatchford et al., 2003), and my problem cases rely extensively on group interactions. Some students in my courses have been frustrated with group learning, and my data suggests these students tend to have more reflective learning styles. My inquiry provides direction to solve future problems with group dynamics and should increase the effectiveness of my implementation of problem cases. For example, if students were aware of their learning style preferences, I could provide targeted study suggestions for students less inclined to value problem cases.

Felder and Brent (2005) caution against explicitly identifying individuals with specific learning style categories, as learning style preferences are not a reliable indicator of what students are or what they are capable of doing. However, students can gain in academic performance if they are given clues about their possible strengths and weaknesses.

Students' learning styles may change through time (Nulty & Barrett, 1996). Students completed the learning style survey before experiencing my course, which may be the first problem-based learning course in their undergraduate curriculum. It is possible that my course may have affected learning styles by the end of the course, when students provided their evaluation of the course. In the future, I would like to assess how student learning styles change as students are exposed to experiential learning in our curriculum (Tucker, 2008).

Problem-based learning may provide critical skills for professional development, but active learning may not be well-matched for all students. Instructors who consider the learning styles of their students should be able to improve the quality of learning experiences.

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Table 1. Details of Wildlife Ecology and Management course at University of Nebraska-Lincoln (UNL) during Spring 2008.

Category	Description
Discipline	Natural Resources, Wildlife Ecology
Course	Wildlife Ecology and Management
Course Level	Sophomore/Junior Year
Number of Students	47
UNL Majors of Students	Fisheries and Wildlife (32), Environmental Studies (3), Rangeland Ecosystems (2), Diversified Ag (2), Ag Education, Biology, Mechanized Systems, Ag Journalism, BSAD, Animal Science, Grazing Livestock Systems, Ag Economics
Type of Course	Required course for Fisheries and Wildlife students, and precedes an upper-level techniques course in either fisheries or wildlife management in the Fisheries and Wildlife major's curriculum. My course also has students from other majors—mostly from the College of Agricultural Sciences and Natural Resources.
Meeting Time	Monday/Wednesday: 50-minute lecture, Wednesday: 50-minute recitation (class broken into two recitation sections to enhance discussions)
Learning Activities	Guided discussions, group work, lectures, discussions of outside-the-text readings, computer labs, and a 8-hour field trip to view sandhill cranes

Table 2. Questions in the problem case survey given to students at the conclusion of a Wildlife Ecology and Management course at the University of Nebraska-Lincoln during Spring 2008.

1. This course was taught with a 'problem case' format, but I really did not think it was different from other college courses I have taken.
2. I thought the 'problem case' format to this course resulted in more applied learning opportunities.
3. I thought the 'problem case' format used in this course caused this course to be harder than if another format would have been used.
4. I believe I will get a higher grade in this course, because it used the 'problem case' format. My grade would have been lower if another format would have been used to teach the course.
5. I believe I have a better understanding of how to approach real-world problems after taking this course.
6. I would NOT enjoy taking another course using the 'problem case' format.
7. The group assignments were valuable experiences, because we had to work as a team to solve a problem.
8. I would say that my group had good discussions as we worked on assignments, and those discussions were valuable to my learning experience in this course.
9. My group did not function well, and I ended up doing more than my share of the work.

Table 3. Summary of results (n = 44) of a learning style survey given to students in a Wildlife Ecology and Management course at the University of Nebraska-Lincoln during Spring 2008. Scores range from -11 to 11; the mean, SD, and quartiles of all students are provided for each dimension. Negative scores indicate preference for first category of pair; positive scores indicate preference for second category of pair (e.g., for the Active/Reflective dimension of learning style, -11 indicates Active and 11 indicates Reflective).

	Learning style dimension			
	Active/ Reflective	**Sensing/ Intuitive**	**Visual/ Verbal**	**Sequential/ Global**
Mean index value	-1.2	-3.3	-6.1	-0.5
SD of mean value	5.0	5.3	4.2	4.9
Quartile Assessment:				
Minimum	-11	-11	-11	-9
25% Quartile	-5	-7	-9	-3
50% Quartile	0	-4	-7	-1
75% Quartile	3	0.5	-3	3
Maximum	11	11	3	11

Table 4. Summary of results (n = 42) of a problem case survey given at the conclusion to a Wildlife Ecology and Management course at the University of Nebraska-Lincoln during spring semester 2008. Results are the number of student responses in each categorical answer. See Table 2 for complete question statements.

	Categorical Answer				
Paraphrased question	Disagree strongly	Disagree	Neutral	Agree	Agree strongly
1. Course was not different than other college courses.	4	14	9	11	4
2. Course had more applied learning opportunities.	0	0	2	24	16
3. Course was harder because of problem cases.	9	19	9	5	0
4. Will get higher grade because of problem cases.	1	3	23	14	1
5. Well-suited to dealing with real-world problems.	0	1	7	22	12
6. I would not enjoy another course like this.	15	25	2	0	0
7. Teamwork was important.	2	4	7	22	7
8. Group discussions were important.	2	2	5	25	8
9. Group did not function well; I ended up doing a lot of work.	16	16	5	2	3

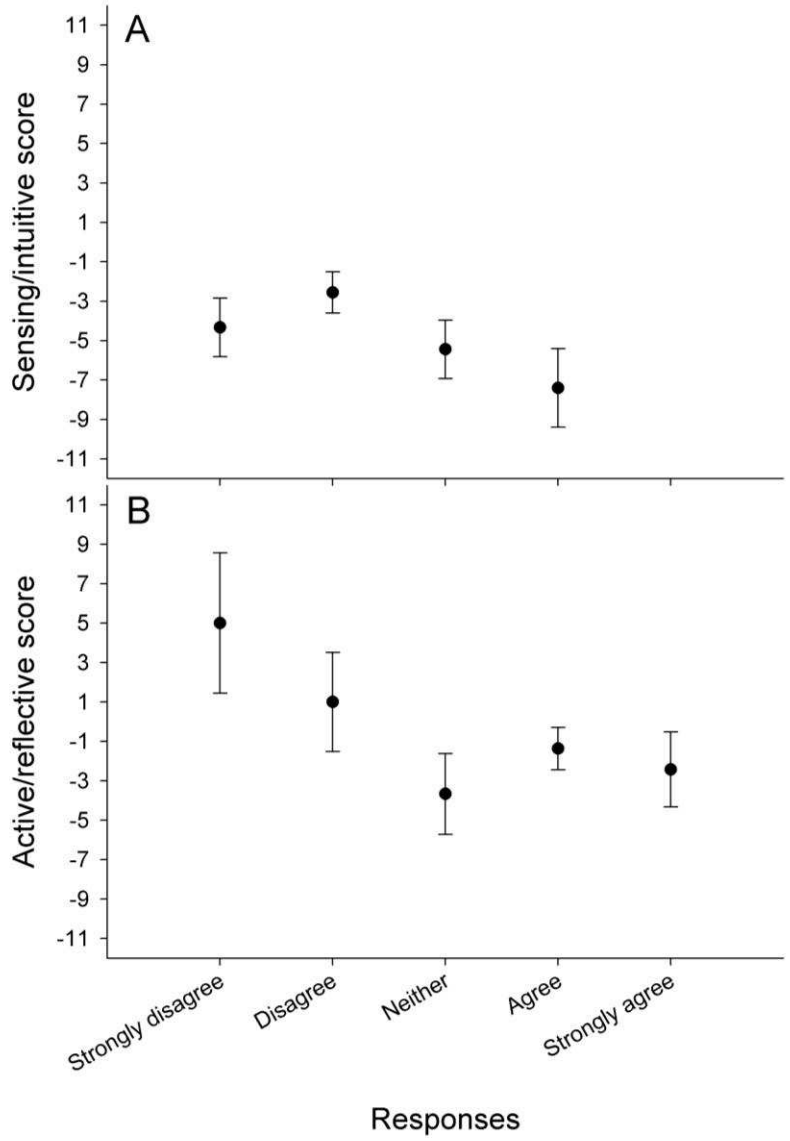

Figure 1. Mean score (least squared mean ± 1 SE) for sequential/global and active/reflective dimensions of learning style (see y-axis) for student responses to the questions (A) *"I believe I have a better understanding of how to approach real-world problems after taking this course"* and (B) *"The group assignments were valuable experiences, because we had to work as a team to solve a problem."* Negative scores in A indicate a tendency to be more sequential, and positive scores indicate a tendency to be more intuitive in learning style. In B, negative scores indicate a tendency to be more active, and positive scores indicate a tendency to be more reflective in learning style.

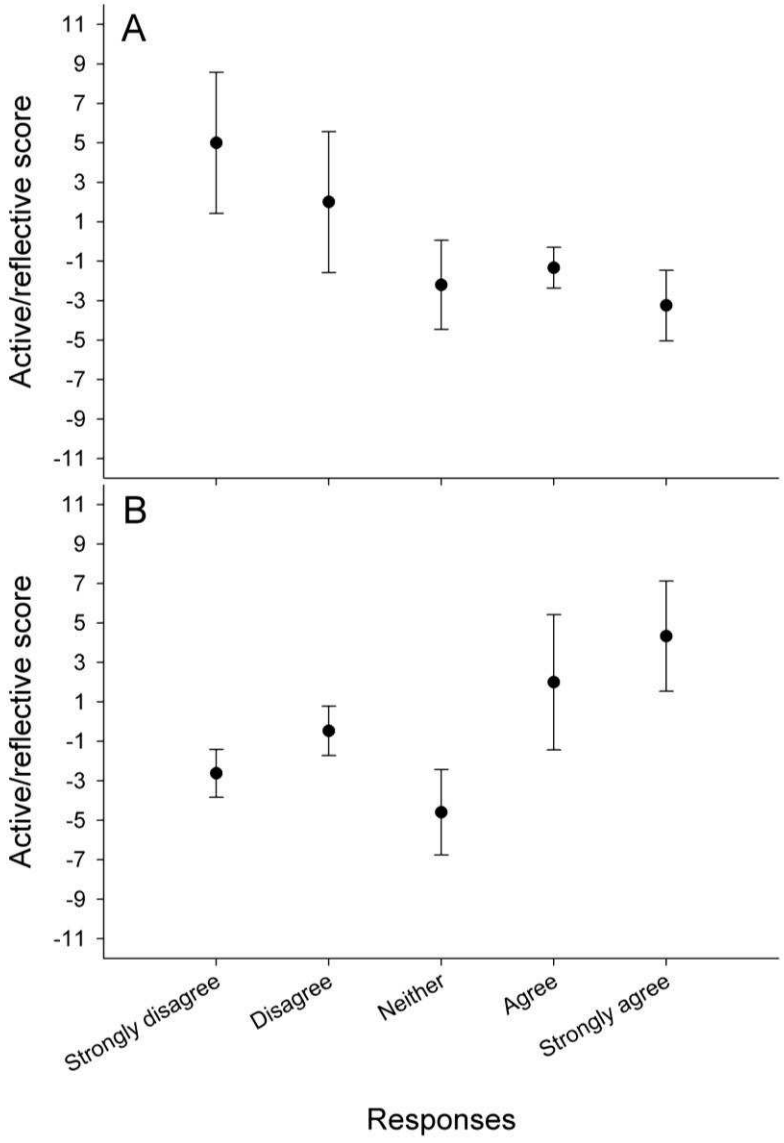

Figure 2. Mean score (least squared mean ± 1 SE) for active/reflective dimension of learning style for student responses to the questions (A) *"I would say that my group had good discussions as we worked on assignments, and those discussions were valuable to my learning experience in this course"* and (B) *"My group did not function well, and I ended up doing more than my share of the work."* Negative scores indicate a tendency to be more active, and positive scores indicate a tendency to be more reflective in learning style.